ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

FINAL REPORT

FY93 LIMITED ENERGY STUDY

MILAN ARMY AMMUNITION PLANT
MILAN, TENNESSEE

CONTRACT NO. DACA01-94-D-0007

Prepared For:

Mobile District
U.S. Army Corps of Engineers
Mobile, Alabama

Prepared by:

Affiliated Engineers SE, Inc.
3300 SW Archer Road
Gainesville, Florida 32608
(904) 376-5500
(904) 375-3479 - FAX

November 11, 1994

DEPARTMENT OF THE ARMY
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES, CORPS OF ENGINEERS
P.O. BOX 9005
CHAMPAIGN, ILLINOIS 61826-9005

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I. Executive Summary

Introduction

In May 1994, Affiliated Engineers SE, Inc. (AESE) was retained by the Mobile District U.S. Army Corps of Engineers to perform a Limited Energy Study for Milan Army Ammunition Plant, Tennessee.

The field survey of existing conditions was completed in June 1994. The results of this field survey were subsequently tabulated and used to generate single line building drawings on Autocad. Several alternative lighting models were examined to determine if a more efficient lighting system could be installed that would produce the same or better lumen levels at these facilities while reducing the buildings' electrical lighting energy consumption.

This report summarizes the results obtained from this field investigation and the analysis of various alternative Energy Conservation Opportunities (ECO's). To develop the field data into various alternative ECO concepts or models, we utilized an "Excel" spreadsheet to tabulate and compare energy consumption, light output, installation and operating costs for various ECO's at these buildings.

These ECO's were then analyzed for suitability for the Energy Conservation Investment Program (ECIP) using the government's software package called Life Cycle Cost in Design (LCCID).

Scope of Work

The Scope of Work developed by the U.S. Army Corps of Engineers gave the following tasks:

1. Perform a field survey to gather information on existing lighting conditions.
2. Provide a list of suggested ECO's.
3. Analyze ECO's using the LCCID program.
4. Perform savings to investment ratio (SIR) calculation.
5. Rank ECO's per SIR's.

6. Provide information on study assumptions and document equations used in calculations.

7. Describe any proposed lighting products with manufacturer's catalog cuts or drawings.

8. Perform Life Cycle Cost Analysis.

9. Perform Synergism Analysis.

10. Calculate Energy/Cost Ratios.

11. Calculate Benefit Cost Ratios.

12. Provide documentation in the form of Project Development Brochures (PDB's) and DD Form 1391.

13. Provide recommendations for implementation of ECO's into projects by ECIP priority.

14. Prepare a report to document the work performed, results, and recommendations.

Buildings examined for Energy Conservation Opportunities were as follows:

A - 2, 3, 4, 6

B - 10, 12, 14, 18

D - 3, 10, 16, 41

H - 81, 111, 115

O - 1, 3, 4

X - 8, 14, 18, 26, 27, 41

Description of ECO's

Existing lighting consisted of mostly incandescents, with a mixture of two and three lamp fluorescent used as task lighting over desks and production belts. A few buildings were distinct. One building was already upgraded with high pressure sodium lighting (X-41), and another with mercury vapor lighting (A-2).

We examined five alternate ECO's models. Before we could start the analysis, we adapted models of the existing systems to fully functioning systems and proposed systems for an equitable comparison. Existing lighting conditions were so poor due to broken fixtures and burnt out light bulbs that we were unable to obtain many footcandle readings without taking them directly under a working light fixture. Thus we started this analysis by theoretically replacing the existing light bulbs, burnt out ballasts, and broken fixtures. We were also then able to introduce a regular relamping schedule into our analysis.

The baseline of this analysis is defined as Alternate 1 as follows:

ALTERNATE 1

Baseline theoretically upgrades the existing fixtures by:

a) Relamping of all fixtures.

b) Replacing failed ballasts in HID and fluorescent fixtures.

c) Replacing broken fixtures to restore Class II, Division 1 rating.

d) Augmenting existing building (C) and belt (B) lighting with a 40 percent increase to attain adequate lighting.

The quantity of light fixtures at ramps (R) and loading areas (L) are assumed adequate and are not increased in quantity. Also individual fluorescents used as task lighting over desks or used as office lighting are not increased in quantity.

Energy Conservation Opportunities are defined as alternates 2 through 6 as follows:

ALTERNATE 2

Replaces the existing fixtures by:

a) Replacing 100 watt, 200 watt, and 300 watt building (C) lighting, ramp (R) lighting, and loading (L) lighting with 70 watt metal halide fixtures.

b) Replacing all belt (B) lighting (both incandescents and two and three lamp T12 fluorescents) with new two lamp 32 watt T8 fluorescent fixtures.

ALTERNATE 3

Replaces the existing fixtures by:

a) Replacing 100 watt, 200 watt, and 300 watt building (C) lighting, ramp (R) lighting, and loading (L) lighting with high pressure sodium lighting. The building (C) and loading (L) lighting are to be 70 watt HPS; the ramp (R) lights are to be 50 watt HPS. Belt (B) lighting is to be changed to two lamp 32 watt T8 fluorescents, as in alternate 2 above.

ALTERNATE 4

Replaces the existing fixtures similar to Alternate 2 with 70 watt metal halides; however, we try to economize by reusing the existing two and three lamp T12 fluorescents. This approach minimizes initial project cost by eliminating replacement of these fluorescents. New belt (B) fluorescents required to be added will be energy savings 3 lamp 34 watt/T12 type with energy savings magnetic ballasts.

ALTERNATE 5

Replaces the existing fixtures similar to Alternate 3 with 70 watt high pressure sodium fixtures at building (C) and loading (L) locations, and with 50 watt high pressure sodium fixtures at ramp (R) locations. As in Alternate 4 above, we also try to economize by reusing the existing two and three lamp T12 fluorescents. New belt (B) fluorescents will be energy savings 3 lamp 34 watt T12 type with energy savings magnetic ballasts.

ALTERNATE 6

Replaces the existing fixtures at Building (C), Ramp (R), and loading (L) lights with 50 watt HPS fixtures. All fluorescents at building (C) and belt (B) lighting will be replaced with 2 lamp T8 type fixtures with magnetic ballasts, as in Alternate 2 above.

When existing building lighting is either mercury vapor or high pressure sodium, the fixtures are to be changed to the specified alternate type or left alone, respectively.

Findings, Analysis, and Results

Our analysis examines the yearly electrical energy consumption and demand charges, the initial installation costs, and the associated operating costs of these alternates as compared to the fully functioning existing system.

Results and recommendations from this analysis are per the attached Tables 1 through 4.

In general, this ECO analysis resulted in multiple feasible options at a particular building which would qualify for ECIP funding. Unfortunately the most successful alternates for each ECO were not a single consistent alternate across the board. The resolution was to select the alternates with the highest SIR possible, yet to be consistent with the types of lighting changeouts so as to minimize the variety of lamps required to be warehoused at the facility.

We were also able to correlate the results such that the recommended projects packaged together were fairly consistent with type of lamp changeout, if not with lamp wattage.

Table 1 provides the results for buildings with feasible ECO alternatives with SIR > 1.25 and with payback < 10 years. We recommend the following packages as a result of synergism analysis, LCCID analysis and the Excel spreadsheet with footcandle analysis and cost analysis:

A-4	Alternate 4	$ 154,789.00
A-6	Alternate 4	$ 3,686.00
B-12	Alternate 4	$ 32,834.00
B-14	Alternate 4	$ 250,435.00
B-18	Alternate 4	$ 211,339.00
D-3	Alternate 4	$ 184,128.00
D-10	Alternate 4	$ 214,182.00
D-16	Alternate 4	$ 25,793.00
D-41	Alternate 4	$ 82,973.00
H-81	Alternate 4	$ 44,355.00
H-115	Alternate 4	$ 74,407.00
X-14	Alternate 4	$ 186,159.00
X-18	Alternate 4	$ 127,345.00
X-26	Alternate 4	$ 11,940.00
X-27	Alternate 4	$ 56,600.00
X-41	Alternate 4	$ 165,233.00

Table 2 provides the results for buildings with feasible ECO alternatives with SIR > 1.25 but with payback > 10 years and < 15 years. We recommend the following:

B-10	Alternate 4	$ 10,440.00
O-1	Alternate 4	$ 21,143.00
O-4	Alternate 4	$ 33,760.00

These projects are combined with other feasible ECO alternatives in our synergism analysis to produce an overall project with SIR > 1.25 and payback < 10 years.

Table 2 also provides the results for buildings with unfeasible ECO alternatives with 1.0 < SIR < 1.25 and simple payback > 10 years. The following buildings and alternates fit into this category:

A-3	Alternate 4	$	90,932.00
H-111	Alternate 4	$	35;703.00
X-8	Alternate 4	$	78,118.00

These projects are not recommended due to required SIR > 1.25 for ECIP funding. They may be implemented however, with facility maintenance money as separate projects. They will provide good energy savings and have paybacks <15 years.

Table 3 provides the results for buildings with unfeasible ECO alternatives with SIR < 1.0 and payback >10 years. We suggest the following buildings and alternates for this category:

A-2 (Alternate 4)
O-3 (Alternate 4)

These projects are not recommended for ECIP funding since their SIR is below 1.0.

Finally, those projects recommended are combined into packages that meet SIR > 1.25, payback < 10 years, and cost > $300,000. Table 4 provides these results in detail. Briefly, the packages and their costs are as follows:

Package 1	$	544,820.00
Package 2	$	313,504.00
Package 3	$	398,310.00
Package 4	$	304,803.00
Package 5	$	330,101.00
TOTAL	**$**	**1,891,538.00**

First year dollar savings, calculated by LCCID, are $210,580. The non-recurring baseline differential cost is distributed through the 15 year economic life of each project. This gives a different number than if the entire savings was shown in the first year.

Annual energy savings for these packages are 1,232,000 kWH.

TABLE 1

FEASIBLE ECO'S RECOMMENDED/ECIP PROJECTS
PROJECT PRIORITY BY SAVINGS/INVESTMENT RATIO
SIR > 1.25, AND SIMPLE PAYBACK < 10 YEARS

PRIORITY NO.	BUILDING NO.	ALTERNATE NO.	SIR	TOTAL INVESTMENT	SIMPLE PAYBACK IN YEARS
1	B-12	6	2.53	$34,981	5.06
2	B-12	3	2.36	$35,770	5.46
3	B-12	5	2.36	$35,770	5.46
4	A-6	6	2.18	$4,037	5.97
5	B-12	2	2.13	$32,834	6.14
6	B-12	4	2.13	$32,834	6.14
7	X-26	5	2.11	$13,266	6.12
8	D-41	6	2.05	$91,590	6.21
9	D-16	6	2.01	$28,254	6.34
10	A-6	3	2.01	$4,129	6.51
11	A-6	5	2.01	$4,129	6.51
12	D-41	3	1.89	$93,640	6.75
13	D-41	5	1.89	$92,934	6.75
14	D-16	3	1.87	$28,785	6.84
15	D-16	5	1.87	$28,785	6.84
16	X-26	6	1.87	$15,887	6.87
17	X-26	4	1.87	$11,940	7.05
18	D-10	6	1.86	$239,673	6.88
19	X-41	6	1.81	$179,588	7.04
20	A-6	2	1.81	$3,686	7.43
21	A-6	4	1.81	$3,686	7.43
22	A-4	6	1.79	$175,641	7.14
23	D-10	3	1.77	$242,663	7.25
24	X-26	3	1.77	$16,101	7.27
25	D-10	5	1.77	$229,947	7.28
26	H-115	5	1.72	$82,805	7.39
27	A-4	3	1.72	$174,566	7.45
28	H-115	6	1.70	$89,265	7.48
29	X-18	5	1.69	$141,257	7.51
30	H-81	5	1.69	$49,275	7.54
31	X-41	3	1.69	$182,565	7.57
32	A-4	5	1.69	$171,402	7.59
33	B-10	6	1.68	$11,436	7.59
34	D-41	4	1.68	$82,973	7.78
35	X-41	5	1.67	$181,214	7.65
36	D-3	6	1.66	$196,091	7.69
37	X-27	5	1.66	$60,904	7.72
38	D-41	2	1.65	$83,965	7.92
39	X-18	6	1.63	$157,366	7.77
40	B-14	5	1.63	$268,119	7.87
41	D-10	4	1.62	$214,182	8.07
42	D-16	2	1.62	$25,793	8.08
43	D-16	4	1.62	$25,793	8.08
44	D-10	2	1.61	$227,918	8.06
45	X-14	6	1.60	$208,302	7.95
46	B-14	6	1.60	$303,272	7.98

TABLE 1
(CONT.)

FEASIBLE ECO'S RECOMMENDED/ECIP PROJECTS
PROJECT PRIORITY BY SAVINGS/INVESTMENT RATIO
SIR > 1.25, AND SIMPLE PAYBACK < 10 YEARS

PRIORITY NO.	BUILDING NO.	ALTERNATE NO.	SIR	TOTAL INVESTMENT	SIMPLE PAYBACK IN YEARS
47	H-81	6	1.59	$56,303	8.00
48	H-115	3	1.59	$90,631	8.02
49	D-3	3	1.59	$197,989	8.04
50	B-18	6	1.57	$244,582	8.12
51	O-1	5	1.55	$23,457	8.26
52	X-26	2	1.55	$14,774	8.48
53	B-18	5	1.53	$226,528	8.34
54	X-14	3	1.53	$210,414	8.34
55	B-14	3	1.53	$306,309	8.35
56	X-18	3	1.52	$159,736	8.34
57	X-27	6	1.52	$73,645	8.38
58	B-10	3	1.52	$11,695	8.42
59	B-10	5	1.52	$11,695	8.42
60	X-14	5	1.52	$199,110	8.44
61	O-4	5	1.51	$37,670	8.44
62	D-3	5	1.51	$195,869	8.50
63	H-81	3	1.50	$57,062	8.50
64	B-18	3	1.49	$247,057	8.52
65	X-27	4	1.48	$56,600	8.85
66	X-41	2	1.47	$167,055	8.87
67	B-14	4	1.46	$250,435	8.95
68	X-27	3	1.45	$74,374	8.80
69	X-41	4	1.45	$165,230	8.98
70	A-4	4	1.45	$154,789	9.13
71	X-8	6	1.44	$93,100	8.86
72	H-115	4	1.44	$74,407	9.03
73	X-8	5	1.43	$85,030	8.94
74	X-18	4	1.43	$127,345	9.10
75	D-3	2	1.42	$187,670	9.17
76	H-81	4	1.40	$44,355	9.33
77	A-4	2	1.38	$166,410	9.51
78	B-14	2	1.37	$288,624	9.46
79	X-14	2	1.36	$197,463	9.57
80	H-111	5	1.35	$39,590	9.36
81	X-8	3	1.35	$94,268	9.46
82	A-3	5	1.34	$108,042	9.51
83	B-18	4	1.34	$211,339	9.70
84	D-3	4	1.34	$184,128	9.76
85	X-14	4	1.34	$186,159	9.79
86	H-111	6	1.33	$46,109	9.53
87	H-115	2	1.32	$82,233	9.87
88	B-18	2	1.31	$232,816	9.86
89	O-4	6	1.29	$49,629	9.85

TABLE 2

FEASIBLE ECO'S NOT RECOMMENDED/NON-ECIP PROJECTS
PROJECT PRIORITY BY SAVINGS/INVESTMENT RATIO
SIR > 1, SIMPLE PAYBACK > 10 YEARS AND < 15 YEARS

PRIORITY NO.	BUILDING NO.	ALTERNATE NO.	SIR	TOTAL INVESTMENT	SIMPLE PAYBACK IN YEARS
1	X-18	2	1.28	$145,823	10.18
2	X-27	2	1.27	$71,137	10.23
3	O-4	4	1.26	$33,760	10.41
4	O-1	4	1.26	$21,143	10.44
5	B-10	2	1.26	$10,440	10.46
6	B-10	4	1.26	$10,440	10.46
7	O-1	6	1.25	$32,293	10.19
8	H-81	2	1.23	$52,142	10.57
9	A-2	5	1.22	$97,016	10.59
10	A-3	4	1.22	$90,932	10.70
11	X-8	4	1.20	$78,118	10.98
12	H-111	3	1.19	$46,655	10.59
13	O-4	3	1.18	$50,434	10.81
14	A-2	6	1.18	$109,706	10.90
15	O-3	5	1.17	$31,542	10.68
16	O-1	3	1.17	$32,673	10.92
17	O-3	6	1.15	$34,051	10.87
18	X-8	2	1.13	$87,808	11.61
19	O-3	3	1.08	$34,399	11.58
20	A-2	3	1.08	$111,255	11.95
21	A-3	6	1.03	$161,934	12.28
22	H-111	4	1.01	$35,703	12.88

TABLE 3

UNFEASIBLE ECO'S NOT RECOMMENDED
PROJECT PRIORITY BY SAVINGS/INVESTMENT RATIO
SIR < 1, AND SIMPLE PAYBACK > 10 YEARS

PRIORITY NO.	BUILDING NO.	ALTERNATE NO.	SIR	TOTAL INVESTMENT	SIMPLE PAYBACK IN YEARS
1	A-3	3	0.98	$163,134	12.91
2	O-4	2	0.96	$46,524	13.49
3	O-1	2	0.94	$30,360	13.94
4	H-111	2	0.89	$42,769	14.50
5	A-2	4	0.89	$87,264	15.39
6	O-3	4	0.79	$28,498	16.43
7	A-2	2	0.78	$101,502	17.44
8	A-3	2	0.77	$155,057	16.90
9	O-3	2	0.72	$31,355	17.90

TABLE 4

SYNERGISM ANALYSIS

PACKAGE NO. 1

BLDG NO.	ALT. NO.	FIRST YEAR DOLLAR SAVINGS	ANNUAL ENERGY SAVINGS (MWH)	TOTAL NET DISC. SAVINGS	TOTAL INVEST.	SIR
A-4	4	$16,957	107	$223,732	$154,789	1.45
A-6	4	$496	3	$6,666	$3,686	1.81
B-10	4	$998	8	$13,149	$10,440	1.26
B-12	4	$5,349	30	$70,079	$32,834	2.13
B-14	4	$27,971	152	$364,485	$250,435	1.46
D-16	4	$3,193	20	$41,763	$25,793	1.62
O-1	4	$2,026	14	$26,593	$21,143	1.26
O-4	4	$3,244	22	$42,434	$33,760	1.26
X-26	4	$1,694	10	$22,326	$11,940	1.87
TOTALS		$61,928	366	$811,227	$544,820	1.49

PACKAGE NO. 2

BLDG NO.	ALT. NO.	FIRST YEAR DOLLAR SAVINGS	ANNUAL ENERGY SAVINGS (MWH)	TOTAL NET DISC. SAVINGS	TOTAL INVEST.	SIR
X-14	4	$19,024	107	$248,801	$186,159	1.34
X-18	4	$13,999	92	$182,069	$127,345	1.43
TOTALS		$33,023	199	$430,870	$313,504	1.37

PACKAGE NO. 3

BLDG NO.	ALT. NO.	FIRST YEAR DOLLAR SAVINGS	ANNUAL ENERGY SAVINGS (MWH)	TOTAL NET DISC. SAVINGS	TOTAL INVEST.	SIR
D-3	4	$18,869	101	$246,764	$184,128	1.34
D-10	4	$26,534	142	$346,593	$214,182	1.62
TOTALS		$45,403	243	$593,357	$398,310	1.49

PACKAGE NO. 4

BLDG NO.	ALT. NO.	FIRST YEAR DOLLAR SAVINGS	ANNUAL ENERGY SAVINGS (MWH)	TOTAL NET DISC. SAVINGS	TOTAL INVEST.	SIR
D-41	4	$10,659	68	$139,286	$82,973	1.68
X-27	4	$6,393	35	$83,587	$56,600	1.48
X-41	4	$18,397	112	$240,051	$165,230	1.45
TOTALS		$35,449	215	$462,924	$304,803	1.52

PACKAGE NO. 5

BLDG NO.	ALT. NO.	FIRST YEAR DOLLAR SAVINGS	ANNUAL ENERGY SAVINGS (MWH)	TOTAL NET DISC. SAVINGS	TOTAL INVEST.	SIR
B-18	4	$21,781	122	$283,386	$211,339	1.34
H-81	4	$4,755	32	$62,081	$44,355	1.40
H-115	4	$8,241	55	$107,402	$74,407	1.44
TOTALS		$34,777	209	$452,869	$330,101	1.37

ENERGY UNIT CONVERSION

- $\frac{\text{kWh x 3413}}{1{,}000} = \text{MBTU}$

- Approximate energy savings at the Milan Army Ammunition Plant is 1,232,000 kWh per year.

- $\frac{\text{1,232,000 x 3413}}{\text{1,000 ,000}} = \text{MBTU}$

  or

  MBTU = ~~4,204,816~~ per year 4,205

  Conversion - $\frac{\text{kWh}}{\text{Yr.}}$ to $\frac{\text{MBTU}}{\text{Yr.}}$

$$1{,}232{,}000 \frac{\text{Kwhr}}{\text{Yr}} \times \frac{3{,}413 \text{ BTU}}{\text{Kwhr}} \times \frac{\text{MBTU}}{1{,}000{,}000 \text{ BTU}}$$

$1{,}232 \times 3.413 = 4{,}205$ MBTU/YR.